

1970 CAAA - 1/27/72

◆ VOC Controls

- storage tanks
- loading facilities
- water separators
- pumps and compressors
- ethylene production

1977 CAAA - 4/24/79

◆ VOC

- NSR

- I/M

- Group I CTG'S

- TCM'S

1977 CAAA - 7/13/81

◆ VOC

– GROUP II

– GROUP III

1990 CAAA

- ◆ 1/11/91 - VOC DEF. ; Nox Monitoring
- ◆ 8/15/91 - RACT Fix-ups
- ◆ 9/28/91 - Barge Loading/Tanker Ballasting
- ◆ 3/04/92 - STAGE II
- ◆ 11/15/93 - Generic RACT
- ◆ 11/15/93 - NSR

CHAPTER 129

- ◆ 129.52 SURFACE COATING PROCESS
- ◆ 129.55 PETROLEUM REFINERIES
- ◆ 129.56 STORAGE TANKS >40,000 GAL.
- ◆ 129.57 STORAGE TANKS <40,000 GAL.
- ◆ 129.58 PET REF -FUGITIVE SOURCES
- ◆ 129.59 BULK GASOLINE TERMINALS
- ◆ 129.60 BULK GASOLINE PLANTS

CHAPTER 129 CONTINUED

- ◆ 129.61 STAGE I
- ◆ 129.62 GENERAL GASOLINE STORAGE
- ◆ 129.63 DEGREASING OPERATIONS
- ◆ 129.64 CUTBACK ASPHALT
- ◆ 129.65 ETHYLENE PRODUCTION
- ◆ 129.67 GRAPHIC ARTS SYSTEMS
- ◆ 129.68 SYNTHESIZED PHARMACEUTICAL PRODUCTS

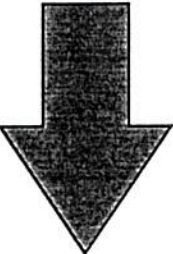
CHAPTER 129 CONTINUED

- ◆ 129.69 PNEUMATIC RUBBER TIRES
- ◆ 129.70 PERC. DRY CLEANERS
- ◆ 129.71 SYNTHETIC ORGANIC MFG
- ◆ 129.72 SURFACE ACTIVE AGENTS
- ◆ 129.81 ORGANIC VESSEL LOADING
AND BALLASTING
- ◆ 129.82 STAGE II
- ◆ 129.91-95 Generic RACT for VOC & NO_x

Predict Changes to Air Quality

- ◆ emission reductions
- ◆ model
- ◆ improved air quality

Ozone is a Secondary Pollutant

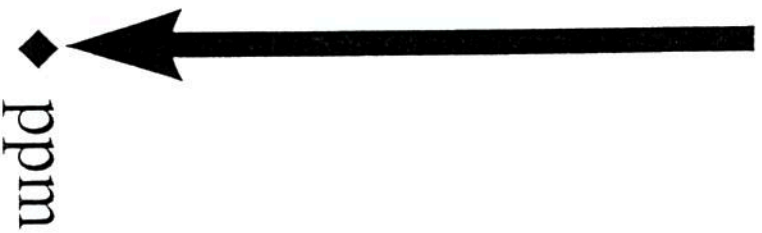
- ◆ VOC + NO_x + Sunlight
 - ◆ Chemical model
- 
- O₃

Dispersion Model

- ◆ wind speed
- ◆ wind direction
- ◆ turbulence
 - stability

Mathematical Model

◆ TPD



◆ ppm

◆ mass per unit time



◆ mass per unit volume

Emissions of Pollutant

- ◆ pounds per hour
(lbs/hr)
- ◆ tons per typical summer day
(TPSD)

Measured Air Quality

- ◆ CONCENTRATION

- ◆ micrograms per cubic meter

- ◆ $\mu\text{gm}/\text{m}^3$

- ◆ parts per million

ppm

(1 part of pollutant for every one million parts of air)

1970 Clean Air Act Amendments

- ◆ EPA Sets Goals
 - National Ambient Air Quality Standards (NAAQS)
- ◆ States Decide How to Achieve Goals
 - State Implementation Plan (SIP)

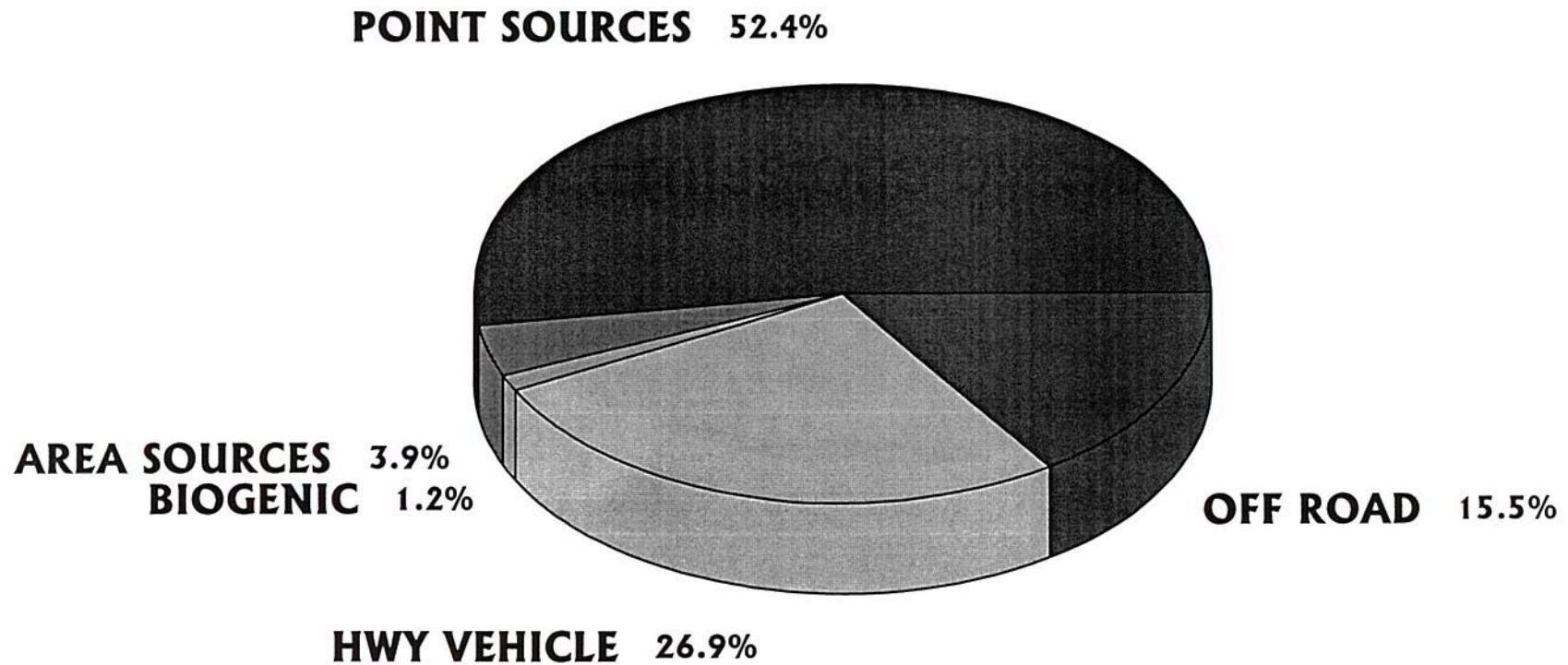
AIR RESOURCE MANAGEMENT

A Conceptual Framework for Air
Quality Planning

State Implementation Plan

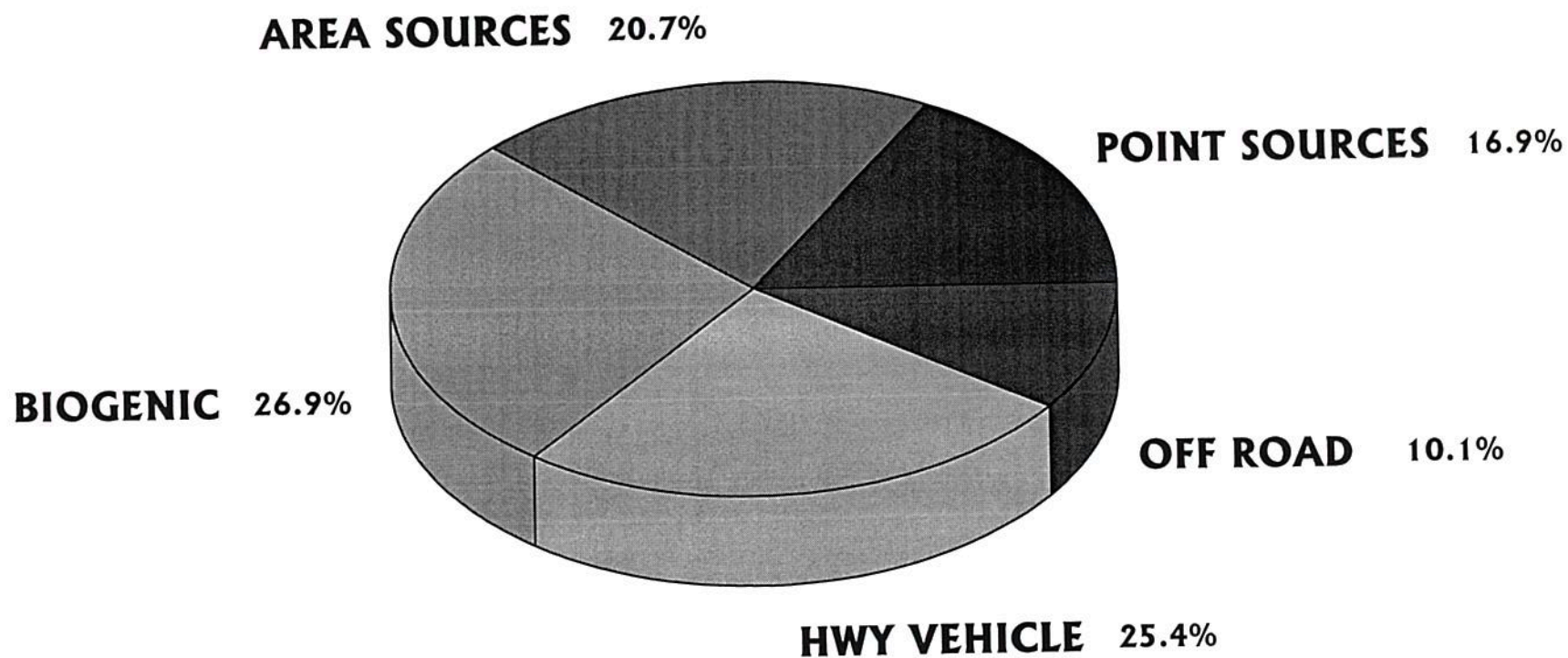
- ◆ Existing Air Quality
- ◆ Sources and Amounts of Emissions
- ◆ Model to Predict Reductions Necessary
- ◆ Schedule to Meet Standards
- ◆ Regulations to Achieve Reductions
- ◆ Attainment Plan
- ◆ Maintenance Plan

Philadelphia Nonattainment Area NOx Emissions by Source



Total Emissions: 1092 tpd

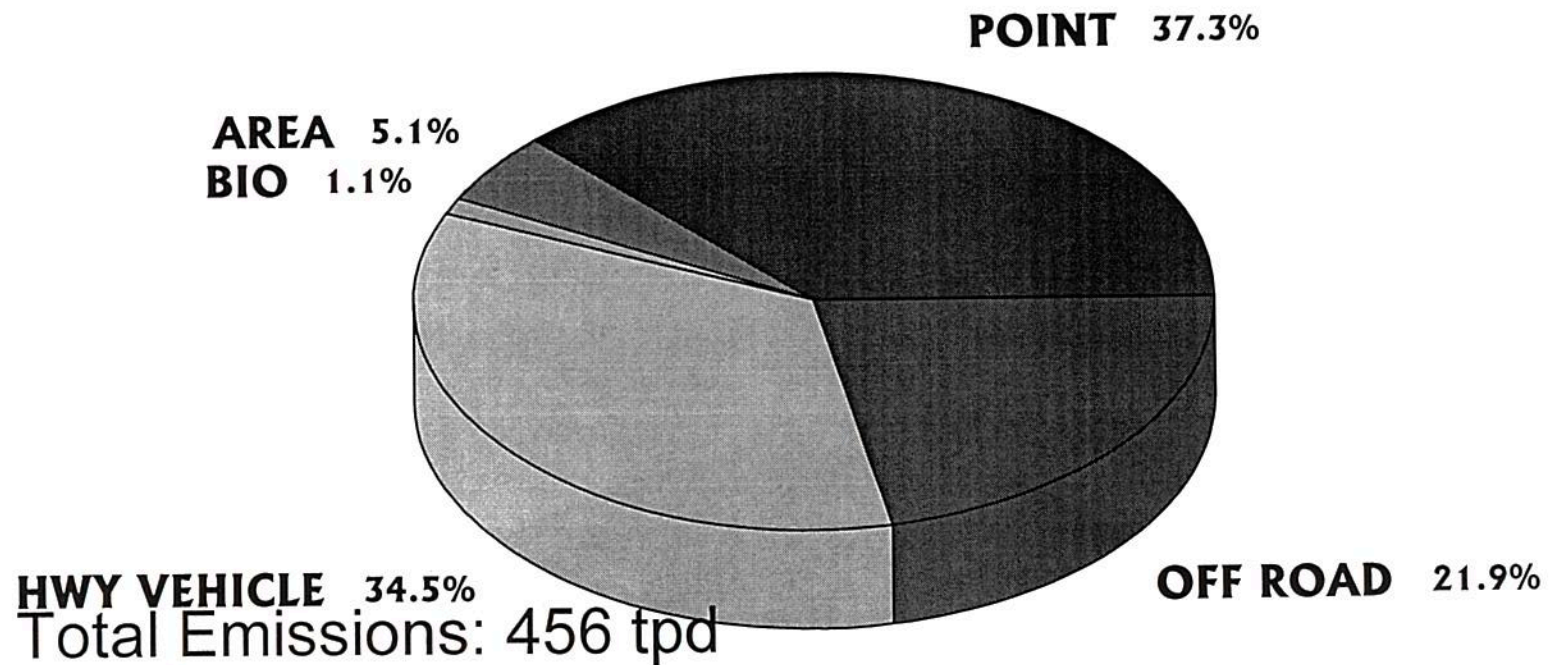
Philadelphia Nonattainment Area VOC Emissions by Source



Total Emissions: 1653 tpd

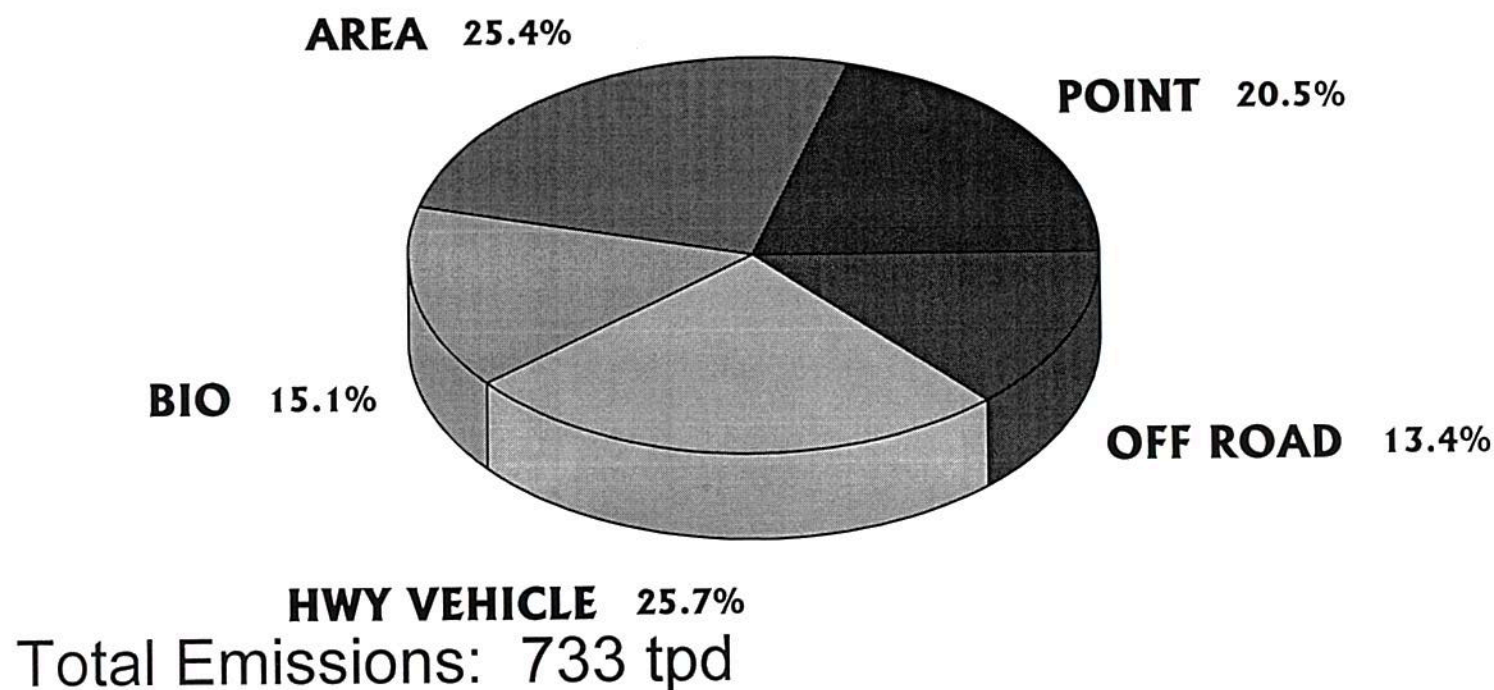
Pennsylvania Portion of Philadelphia Nonattainment Area

NOx Emissions by Source

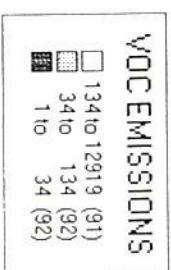
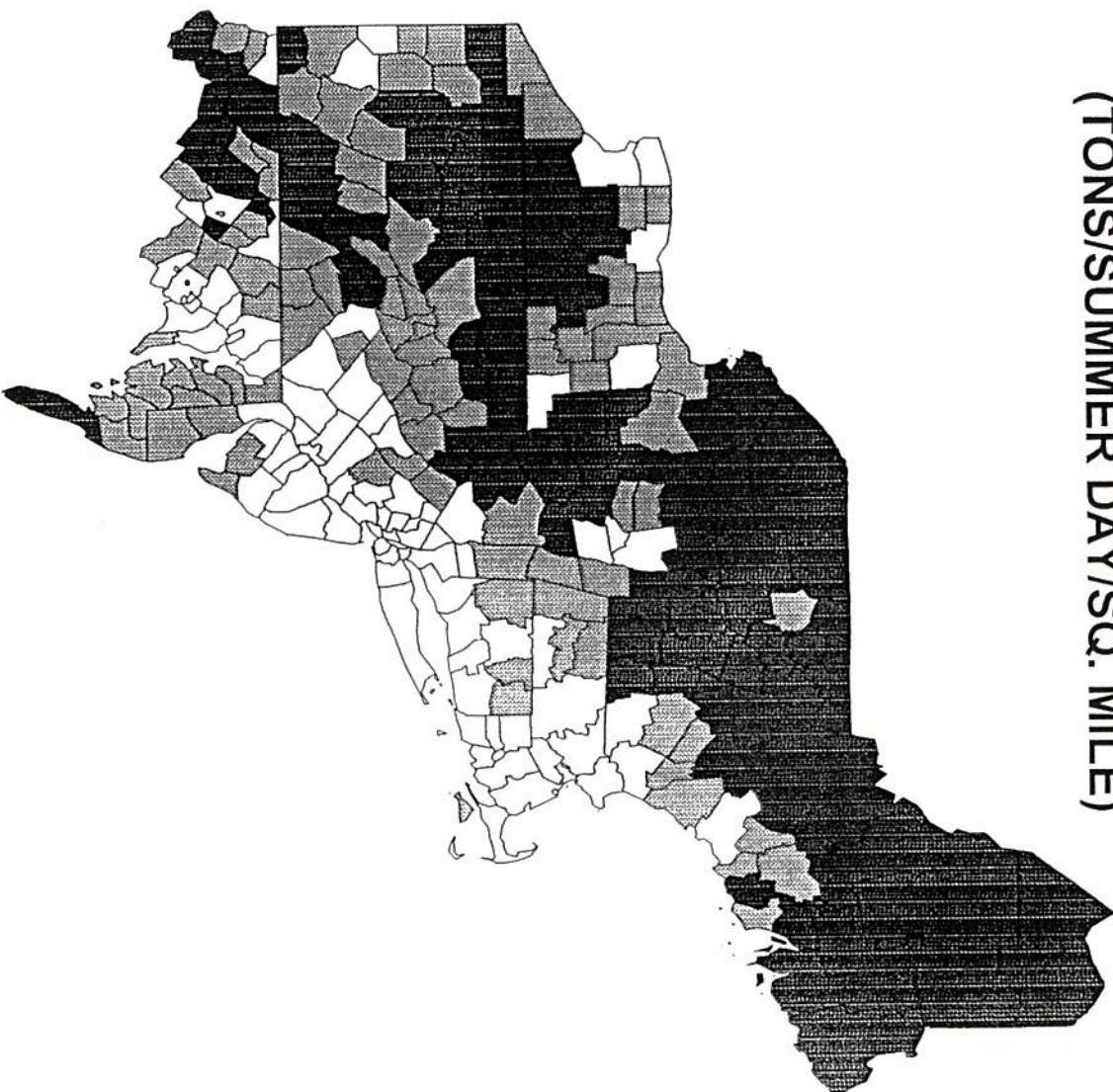


Pennsylvania Portion of Philadelphia Nonattainment Area

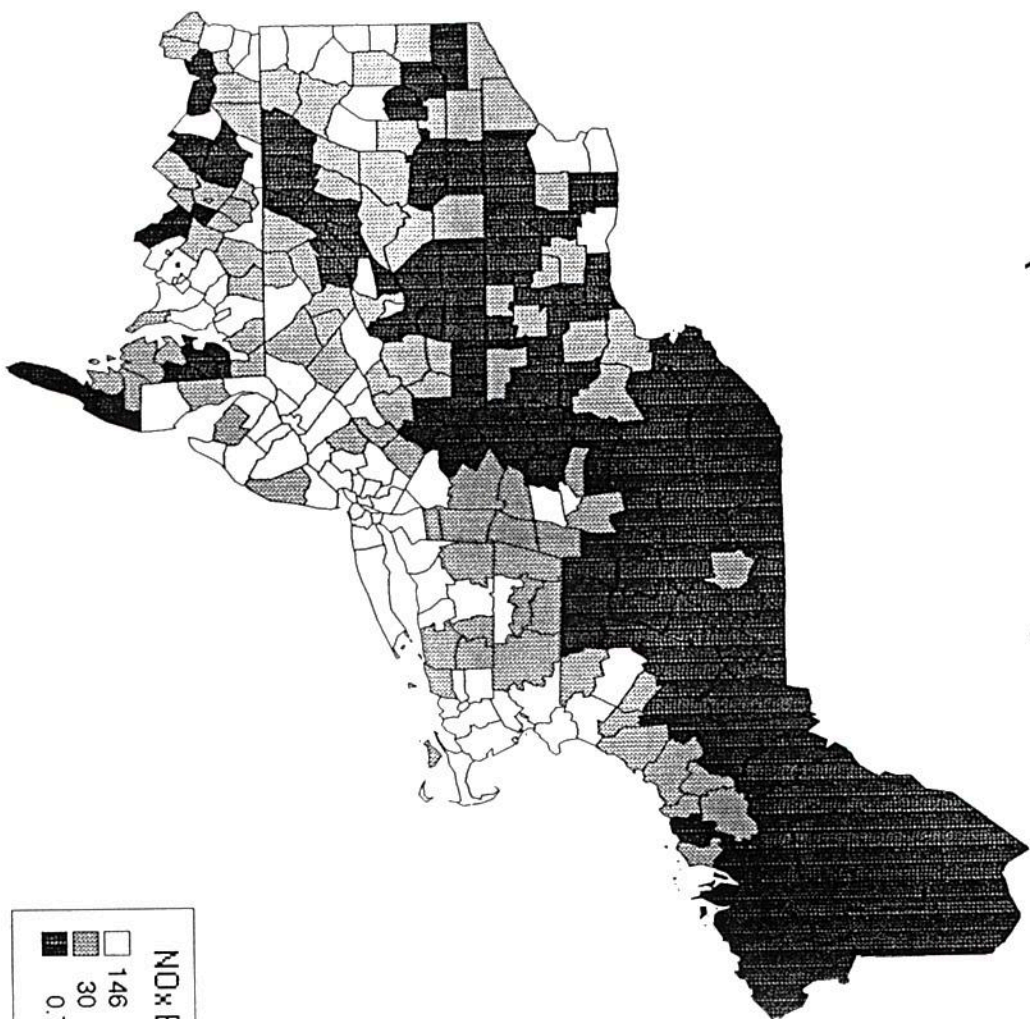
VOC Emissions by Source



1990 VOC EMISSION DENSITIES IN THE OTR (TONS/SUMMER DAY/SQ. MILE)



1990 NOX EMISSION DENSITIES IN THE OTR (TONS/SQ. MILE)



NOX EMISSIONS		
146 to 10614	(91)	
30 to 146	(92)	
0.7 to 30	(92)	

Questions and Answers About the Clean Air Act: Exploding Some Myths

Why standards that are based on protecting public health?

Protection of health is widely accepted as the appropriate objective of federal law. In 1970, the Manufacturing Chemists Association (now the Chemical Manufacturers Association) said that it assumed proposals would “make it clear that the effects of air pollution agents upon the more sensitive—the very old, the very young, those with severely limited respiratory reserves—should be considered by the Secretary, and we would certainly agree it appropriate for him to do so.”¹⁰⁶

“Society has a responsibility to protect the more vulnerable segments of its population.”

Manufacturing Chemists Association, 1970

“Society has a responsibility to protect the more vulnerable segments of its population,” the Association said.

Chicago steelworker Joseph Germano told the Senate Committee, “Prosperity doesn’t mean anything if (you’re) not going to live to enjoy the prosperity.”¹⁰⁷

Rep. Charles Vanik of Ohio said as the House of Representative approved the Conference Report, “Human health and comfort has been placed in the priority in which it belongs—first place.”¹⁰⁸

Why not require comparisons of costs and benefits?

Standards based on a weighing of costs and benefits suffer from two sorts of problems, either of which is fatal. First, they are impractical and unworkable. Second, they are unethical.

The Near Impossibility of Calculating Costs.

Proponents of cost-benefit analysis assert, and many people accept without challenge, that the costs of complying with environmental requirements can be calculated fairly easily. Yet experience for a quarter century demonstrates that calculating cost can be

every bit as difficult as predicting benefits, and sometimes even more so. This makes weighing of costs and benefits difficult under the best of circumstances, but sometimes impossible when dealing with air pollution.

Unknown and unknowable control costs.

Controls costs can be not merely unknown, but unknowable, especially at the outset of a control program. For example, when the 1970 amendments were adopted, commercially available catalytic converters for cars did not exist, nor did some “scrubbers” for powerplants. How can costs be calculated, when the control technologies or practices have yet to be invented, much less commercialized? Even when costs can be assigned to a given technology, they tend to drop sharply, sometimes precipitously, when commercialization occurs.

When they were proposed in the wake of the 1973-74 oil embargo, U.S. car makers resisted the fuel economy standards bitterly, saying they would “outlaw full-size sedans and station wagons,” (Chrysler), “require all sub-compact vehicles,” (Ford), and “restrict availability of 5 and 6 passenger cars regardless of consumer needs,” (General Motors).

Cost drop. A recent example of this cost-drop phenomenon is the ban on use of chlorofluorocarbons, adopted at a time when substitutes hadn’t been invented or commercialized. The costs were vastly less than initially believed and, in some cases, were negative. At Hughes Aircraft, for example, an inventive engineer developed a process for eliminating CFCs that is non-toxic, safe for stratospheric ozone, not a contributor to smog and cheaper. The company now realizes roughly \$3 million annually in sales from the product, which is based on lemon juice. Sometimes, projections are simply wildly incorrect.

For example, when they were proposed in the wake of the 1973-74 oil embargo, U.S. car makers resisted the fuel economy standards bitterly, saying they would "outlaw full-size sedans and station wagons," (Chrysler), "require all sub-compact vehicles," (Ford), and "restrict availability of 5 and 6 passenger cars regardless of consumer needs," (General Motors).

Differences in projections. Even when costs can apparently be calculated in a relatively straightforward way, there is a wide range. When acid rain controls were being considered by the Congress during the 1980s, for example, the control technology options were quite limited—most utilities were proposing either to install scrubbers or switch to lower sulfur coal—but the range of cost calculations were huge. As Congressional Research Service of the Library of Congress reported on the "scores of acid rain cost studies conducted"—

*What is not clear is how much the costs of acid rain control would be. Various econometric and utility studies have presented a wide range of cost estimates. In some cases, a factor of 10 separates these estimates. Similar discrepancies exist regarding estimates of potential coal miner employment.*¹⁰⁹

Profits instead of costs. Increasingly, companies are satisfying environmental requirements through process or product changes that enhance their efficiency and competitiveness, not through the purchase of add-on control technologies. Leading proponents of this approach include Minnesota Mining and Manufacturing (3M), which has operated a Pollution Prevention Pays (3P) program since the mid-1970s; AT&T, the \$65 billion communications firm that incorporates environmental protection into its product design; and, Quad-Graphics, a \$1 billion printing company that reduces air pollution by reformulating its inks and improving its printing process, thus lowering costs and developing marketable products.

In those rare—or misleading—cases where costs can be quantified, they are more likely to be high where air is the dirtiest, not where it is the cleanest. As the National Commission on Air Quality, a 13-member group that conducted a two-year top-to-bottom review of the Clean Air Act said in 1981—

*If a national air quality standard were based in part on the cost of complying with it, the very high costs of meeting the standard in a few severely polluted areas would probably require that the standard be set at a less protective level than is achievable in a reasonable economic fashion in most areas of the country.*¹¹⁰

For these and other reasons, cost-benefit balancing has been rejected repeatedly in the last 25 years. In 1970, for example, the Nixon Administration opposed such proposals when they were suggested in the House of Representatives. At that time, the House bill would have required cost-benefit analyses of alternative emissions control devices for motor vehicles. The Nixon Administration opposed cost-benefit analysis because it would require "extensive, time-consuming testing of emission control devices and systems to evaluate their performance in the presence (in varying amounts) and absence of specific components of fuels."¹¹¹

An equally compelling argument can be made against cost-benefit balancing on the grounds of both practicality and ethics. In order for benefits to be balanced against control costs, a dollar value must be assigned, not only to life itself, but a wide range of other illnesses. The intelligence of small children, for example, must be assigned a dollar value, as well as the pain suffered by Jessica Buckmaster and other children racked by asthma. Nettie Lee's life would have to be given a dollar value, and so would that of the 45-year-old men who might suffer a fatal heart attack because of lead. Momentary drops in the oxygen supply to fetuses would be assigned a value as well. Would that be only a few pennies or many dollars?

what is the value of a loss to America of a Thomas Edison, Margaret Mead, Martin Luther King, Thomas Jefferson or, for that matter, Bill Gates or Newt Gingrich?

Assuming that the full range of health effects—everything from increased hospital admissions caused by ozone to the deaths resulting from particulate matter—could be identified and assigned a value, the task of calculating the number

of these events would remain. Is the number of Americans killed by particulate 50,000 each year or 100,000? Is the intelligence destroyed by lead one IQ point or five, and how many children is that in the aggregate? Is the value of the intelligence loss greater when the child is at genius or near genius level—that is, what is the value of a loss to America of a Thomas Edison, Margaret Mead, Martin Luther King, Thomas Jefferson or, for that matter, Bill Gates or Newt Gingrich?

Assuming that all these difficulties can be overcome, one question remains: should they. As former Sen. Robert T. Stafford, one of the drafters of many of America's environmental laws, said—

“America did not abolish slavery after a cost benefit analysis nor prohibit child labor after a risk assessment. We did those things because money is only one way of expressing value, and sometimes it is the least important.”

Former U.S. Senator Robert T. Stafford (R.Vt.)

America did not abolish slavery after a cost benefit analysis nor prohibit child labor after a risk assessment. We did those things because money is only one way of expressing value, and sometimes it is the least important.

This is not merely a question of ethics, but runs to a fundamental question as to the proper role of government and the social consequences of decisions that implicitly sacrifice the health or well being of one party for the economic benefit of another. Even Adam Smith, the intellectual father of the free enterprise system, reached this conclusion. He supported, for example, government-imposed monopoly under certain circumstances such as the protection of intellectual property through patents. Initially famed for his work on social philosophy, expressed in *The Theory of Moral Sentiments*, written in 1759, rather than for theoretical economics as outlined in *The Wealth of Nations* (1776), Smith argued that government administration of a body of “positive law” was essential. “Without this precaution,” explained Smith, “civil society would

become a scene of bloodshed and disorder, every man revenging himself at his own hand whenever he fancied he was injured.”

Why not simply require all sources to install the best pollution control technology that is economically and technologically feasible?

This approach was tried during the 1950s and 60s, but progress was so slight that in 1967 the Senate committee report on the Air Quality Act of 1967 warned that “considerations of technology and economic feasibility, while important . . . should not be used to mitigate against protection of the public health and welfare.”¹¹² But they were, and in 1970 Sen. Muskie declared on the Senate floor that “we have fallen behind in the fight for clean air.” Muskie added that technology-following had failed: “We have learned that tests of economic and technological feasibility applied to those standards compromise the health of our people”¹¹³

Why ambient standards?

Ambient standards, whether for an airshed, watershed, or tap water, are not directed at a particular regulatory target. Thus they give states—or in some cases, regions—flexibility. Los Angeles, for example, can develop an air quality plan focused on tailpipe emissions, Houston on refineries, Ohio on powerplants, and New York City on fuel oil. Montana or Wyoming, on the other hand, may be required to adopt few, if any, controls except to prevent air or water from becoming degraded, an approach which the Manufacturing Chemists Association supported as “tailoring” control programs “to the specific characteristics of each—their origins and the means available for their solution.”¹¹⁴ The Association emphasized the importance of such tailoring, saying that—

The development of a body of law and regulatory controls to implement such a concept must necessarily proceed in a stepwise fashion, and inevitably the path traced towards its ultimate objective will, viewed in retrospect, deviate from the straightest and most direct route. To the degree that the enunciation of this concept in the basic legislation is clear and explicit, providing sharply delineated goals and machinery for the early detection and prompt correction of misdirected efforts, our progress toward a

*pollution-free environment will be speeded and straightened.*¹¹⁵

National ambient standards were adopted by the Congress because source-specific emission standards hadn't worked.

National ambient standards were adopted by the Congress because source-specific emission standards hadn't worked. As Sen. Muskie explained in 1970, "(W)e have learned much from the operations of the laws passed in 1963, 1965, and 1967 . . . emissions standards will not—and probably cannot—guarantee ambient air quality which will protect the public health."¹¹⁶

Why ambient standards that are nationally uniform?

Before 1970, States established their own ambient standards based on the air quality criteria documents prepared by the federal government. Among those recommending a shift to federal standard-setting was President Richard Nixon. Secretary of Health, Education and Welfare Robert Finch explained that there were "three principal advantages" to this change:

First, the States cannot be expected to evaluate the total environmental impact of air pollutants, or take it into account in standard-setting.

Second, States would be able to concentrate their resources on the critical tasks of implementation and enforcement.

*And third, the process of putting air quality standards into effect would be accelerated, because there would be no time consumed in reviewing and approving standards for each air quality control region.*¹¹⁷

Industry and labor also supported nationally uniform standards, though for different reasons. The Manufacturing Chemists Association (now the Chemical Manufacturers Association) said, "the concept of federal ambient air standards received wide support (at subcommittee hearings) on the basis that the need to hold the tedious and divisive ambient air

standard setting hearings at the state level would be eliminated."¹¹⁸

In a letter to the Chairman of the Senate Committee, Sen. Jennings Randolph, Andrew J. Biemiller of the AFL-CIO supported national air quality standards, including land use plans, traffic control measures, emissions controls, enforcement and other measures. "One of the major accomplishments that can be expected," he wrote, was "stopping the industrial blackmail to which workers are subjected by industries which threaten to leave or do leave states or areas with tough anti-pollution programs to those which do not."¹¹⁹

The standards established by the law were not intended to be the most stringent or comprehensive possible. They are instead the minimum required to protect health. Although these minimum standards are nationally uniform, states that wish to adopt more stringent or comprehensive requirements can and some have (e.g. California).

Why protect "sensitive" populations?

The Clean Air Act requires "sensitive groups" to be protected for many reasons, but chief among them are two: first, these groups, which critics like to suggest are vanishingly small, number in the tens of millions; and, second, they are signals of a threat that may be posed to the entire population.

If a health-based standard were set to protect the public as a whole, very large fractions of the population would be left unprotected.

If a health-based standard were set to protect the public as a whole, very large fractions of the population would be left unprotected. There is, for example, little or no evidence that lead raises blood pressure in women, possibly increasing the risk of heart attack and stroke, even though lead is associated with that risk in white middle-aged and older men. Lead also destroys intelligence in infants and children. Thus, an ambient standard that protected the population as a whole, but didn't focus on groups within it, would leave enormous numbers of Americans—middle aged men and children in this example—exposed to pollution caused disease.

Although critics of the Clean Air Act sometimes imply that the sensitive populations are tiny fractions, they can number in the tens of millions.

Although critics of the Clean Air Act sometimes imply that the sensitive populations are tiny fractions, they can number in the tens of millions. Bronchial asthmatics and emphysematics, for example, are among those explicitly named as protected populations. That's more than one in every twenty citizens. Asthmatics alone are five percent of the total U.S. population and an even higher fraction of children.

Children are also protected, and while that's now about 22 percent of the population, at one time or another every American is a child—a child whose intelligence could be destroyed by lead or lungs seared and scarred by ozone. Most women become pregnant, and when they do, they and their unborn children are protected as part of the population sensitive to carbon monoxide. As men reach middle age, many develop heart conditions—and thus become part of yet another sensitive population protected from carbon monoxide.

Nor are these groups engaged in extraordinary activities. Indeed, sensitive populations are those who *"in the normal course of daily activity* are exposed to the ambient environment. (emphasis added)"¹²⁰ Normal activities include playing at recess for children, jogging for non-smokers, digging ditches for construction workers and simply breathing for the elderly, pregnant women and, in the case of lead, infants and children.

Polluters sometimes say that in establishing standards EPA selects exquisitely susceptible individuals, such as the most severe elderly asthmatics, for example. In one lawsuit, for instance, the American Petroleum Institute claimed that EPA had based the ozone standard on "persons more sensitive than 99 percent of the sensitive subgroup."¹²¹ Again, this is simply untrue. At levels of ozone established by the standard that API was seeking to overturn, healthy, non-smoking young men—not even asthmatics, much less the most sensitive 1 percent of asthmatics—are unable to breathe normally when they exercise.

For purposes of determining whether pollution actually causes an adverse effect, the Clean Air Act requires reference to "a statistically related sample."¹²² So, for establishing the lead standard, for example, EPA could have selected as the sensitive population children who live in houses painted with lead-based coatings—but it didn't. Or, the Agency could have selected men and women who worked in or around industries that use lead—but it didn't. Nor did the Agency choose children that live near the many lead smelters in the United States as the sensitive population. Instead of any of these smaller populations, the Administrator chose to protect the child with *average* contamination.¹²³

Why protect against mere "discomfort?"

Critics of the Clean Air Act sometimes assert that it requires industry to spend billions of dollars merely to protect against discomfort—watery eyes, for example. Yet just as a slight temperature signals an infection, so too do symptoms such as difficulty in breathing, watery eyes or chest tightness provide objective warning that something serious is happening to the body.¹²⁴

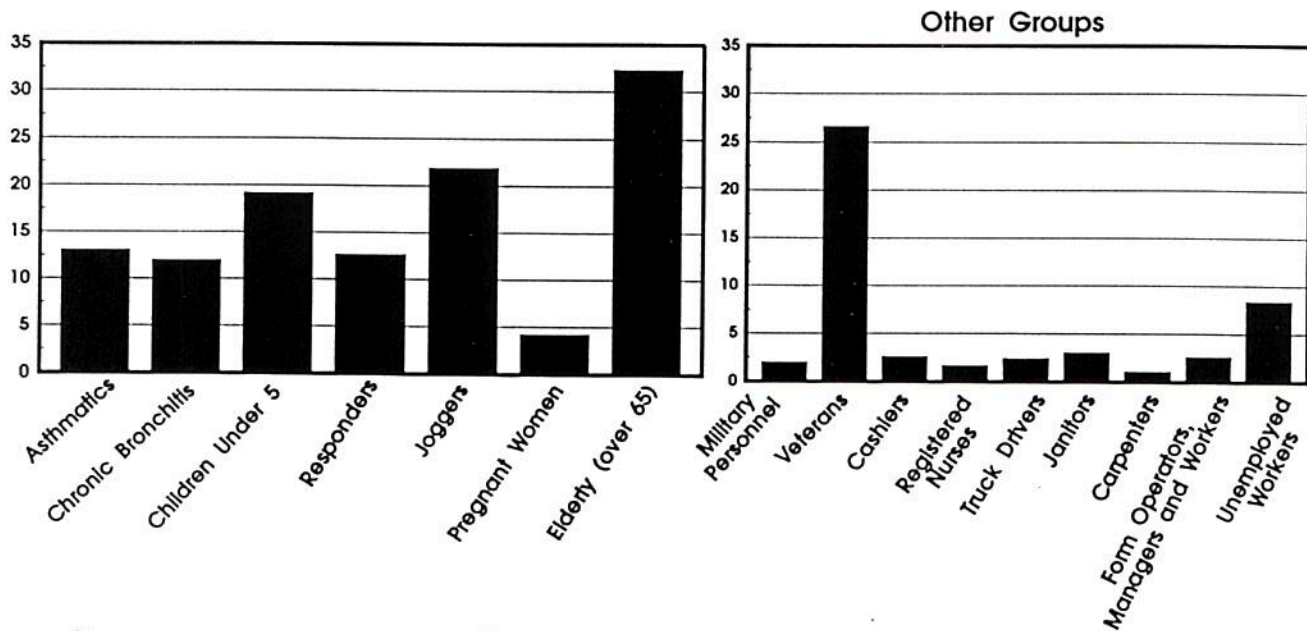
Characterizing symptoms as mere discomforts is an attempt to trivialize the kinds of health effects that the Congress was concerned about, as expressed in the 1977 Committee Report from the House of Representatives:

*... initiation of, or contribution to, the inducement, or aggravation of asthma, emphysema, chronic bronchitis, congenital abnormalities of the lung, impairment of the body's defense mechanism, coronary heart disease and/or hypertension, impaired fetal development, harm to red blood cells and anemias, and accelerated aging.*¹²⁵

Why add a margin of safety?

The Clean Air Act not only requires that the health of sensitive groups be protected, but that a "margin of safety" be built into a standard. This strikes some

Size of Sensitive Populations Compared To Other Groups¹



¹Source: Statistical Abstract of the United States.

as overkill—taking a standard that already is stringent because it protects the sensitive, then making it even more so. In fact, that is not the result, because the margin of safety serves to make the law more workable.

Under previous law, pollution was subject to abatement if it “endanger(ed) the health *or welfare of any persons.*” (emphasis added) Thus, the law protected not merely health, but “welfare” as well; and, it protected not merely statistically valid groups of sensitive populations, but “any persons.”¹²⁶

Also, prior to 1970, standards were set on a regional or local basis and had to reflect “variable factors” that might heighten vulnerability to pollution. Factors that expressly had to be taken into account included “atmospheric conditions” and any other air pollutant that “may interact . . . to produce an adverse effect.”¹²⁷ Thus, pre-1970 law not only required adjusting standards to take into account altitude, humidity, temperature, the presence of naturally

occurring pollutants, and a wide variety of other factors but allowed standards to protect any persons.

By substituting a margin of safety, the 1970 amendments vastly simplified this standard setting process and, as a result, eliminated the need for industries to comply with potentially hundreds of differing standards. As Dr. John Middleton, then head of the National Air Pollution Control Administration, told the Congress: “(It is) because of environmental factors, physical factors of the environment . . . that a margin of safety is necessary.”¹²⁸

The margin of safety also overcomes an otherwise formidable practical and ethical obstacle. Although ambient standards protect sensitive groups—children, pregnant women and severe asthmatics, for example—from air pollution, testing such people is both unethical and impractical. Unethical, because some of them could, quite literally, be killed or permanently crippled by tests. Impractical, because

adverse health effect levels for sensitive groups are difficult or impossible to determine experimentally.¹²⁹ The margin of safety overcomes both the ethical and practical obstacles, by allowing a standard to be established on the basis of what a healthier segment of the population can tolerate, then adjusting it to protect more vulnerable groups.¹³⁰ The alternatives to the margin of safety are either to leave these groups with no room for error in the science or to subject them to tests that could prove fatal or permanently disabling.

Still, the most compelling reason for a margin of safety is humanity's fundamental ignorance about exactly how air pollution damages human health. Scientists know, for example, that particulate air pollution kills upwards of 50,000 Americans each year—yet an understanding of how this happens continues to elude them. It is also well settled that lead destroys intelligence, yet how is a mystery, which should come as no surprise since science doesn't fully understand the brain itself. And, ozone burns through cells walls, in effect dissolving them. But, once again, how it does this on the molecular level isn't known.

"Margins of safety," said the Senate Committee report in 1970, "are essential to any health-related environmental standards if a reasonable degree of protection is to be provided against hazards which research has not yet identified."

"Margins of safety," said the Senate Committee report in 1970, "are essential to any health-related environmental standards if a reasonable degree of protection is to be provided against hazards which research has not yet identified."¹³¹

Thus, margins of safety operate with the protection of sensitive groups to make the Clean Air Act workable from a practical perspective. Together, they make it possible to draw a line for protection of human health in those cases where science is unable to find such a threshold.

It bears repeating that although some of the current standards were set only a few years and incorporate margins of safety, they already have been overtaken by a large body of scientific evidence linking those supposedly "safe" levels of air pollution with upwards of 50,000 premature deaths, loss of the ability to breathe normally, increased wintertime illnesses and emergency room admissions, and sickness severe enough to force people to miss work and school.

Why impose a "one percent solution?"

In some cities, especially those with air that very nearly meets the ambient standard for ozone, only a few monitors—perhaps just one—may show a reading that is just marginally above the relevant level. It seems sensible to ask why should such an area be required to install additional pollution controls? Why should controls be required 100 percent of the time, when non-attainment is only one percent of the time?

In some cases—and ozone is the most notable of these—violation of the standard is not merely an illness, but a symptom. In some sicknesses, mononucleosis, for example—a child may have only a slight fever and even then only for a brief period at certain times during the day. The fever is only a half a degree, which is less than one percent of normal; and, it's high for only an hour or so during the day. Despite this, the child is sick 24 hours a day and the illness is not one to be taken lightly—it's serious.

The same is true of the ozone standard. It was intentionally set, both in terms of duration and level, to also reflect longer-term ozone values. To use a crude analogy, both the height and number of mountain peaks is one way of measuring the average height on the range in which they are located. Areas that violate the one-hour ozone standard, even by just a little, pose two threats to human health:

- An acute threat, because breathing ozone at .12 parts per million begins the process of burning

holes through cell walls, triggering chest pain, shallow and rapid breathing, and lessening the ability to breathe normally; and,

- A chronic threat, because an area with a peak of 0.12 parts per million ozone has longer-term, slightly lower concentrations of ozone that may cause subtle, but long-lasting impacts. In animals, these include changes in cell shape and size, as well as increases in lung stiffness.

Nationally, 12.1 million children live in areas that violated the one-hour standard for ozone, but twice as many—27.1 million—live in areas that had levels of ozone of 0.08 for more than eight hours.

Nationally, 12.1 million children live in areas that violated the one-hour standard for ozone, but twice as many—27.1 million—live in areas that had levels of ozone of 0.08 for more than eight hours. In some senses it would be simpler—it certainly would be more understandable—to have two ozone standards, one to guard against acute threats and another against chronic exposures. What many critics of the short-term standard are seeking, however, is a weaker short-term standard and nothing at all to guard against longer-term exposures.

Why penalize hot summers?

The weather is a fact of life when it comes to air pollution. Sulfates and nitrates become acids in rain, snow or fog, for example. Storms and prevailing winds blow pollution from Chicago to Milwaukee and from New York to Connecticut. But most of all, hot weather creates ozone—or does it?

Sunshine and Smog¹

Cities With Worst Smog ²	Cities on Both Lists	Cities with Most Sunshine ³
Southern California (124.8)	Southern California	Phoenix (86%)
Houston—Galveston CMSA (16.2)		El Paso (83%)
New York City CMSA (12.7)		Reho (79%)
Boston CMSA (10.0)		Sacramento (78%)
Sacramento (9.9)	Sacramento	Los Angeles (73%)
Portland, Me. (9.1)		Miami (73%)
Chicago—Gary CMSA (8.6)		Denver (70%)
Springfield, MA (7.7)		Honolulu (69%)
Greater Connecticut (7.4)		Oklahoma City (68%)
Greensboro—Winston Salem (7.2)		San Diego (68%)

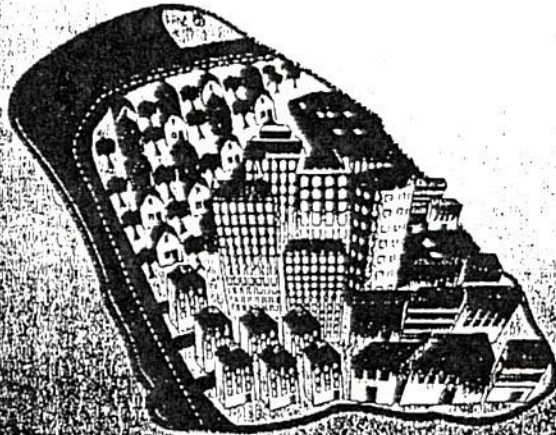
¹Source: Statistical Abstract of the United States 1992, Tables 356 and 375.

²Average number of days in which the ozone standard was violated over the period 1988–90.

³Average percentage of possible sunshine based on airport data.



WORKING TO COOL



**URBAN
HEAT
ISLANDS**

On warm summer days, the air in a city can be 6–8°F hotter than the surrounding countryside. Scientists call these cities “Urban Heat Islands.”



In these cities, the temperature on the hottest summer day is rising by up to 1°F each decade.

Urban Heat Islands have been created over time here in the United States and around the world. In Baltimore, Phoenix, Tucson, Washington, Shanghai, and Tokyo, for example, scientific data show that July's maximum temperatures during the last 30 to 80 years have been steadily increasing at a rate of one half to one degree Fahrenheit every ten years.

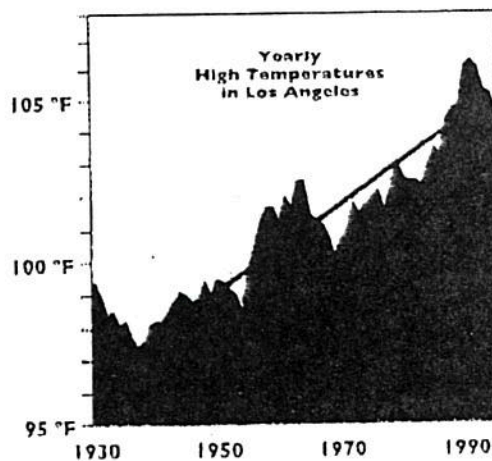
How Do Cities BECOME HEAT ISLANDS?

Temperatures are higher in cities because

- There are few trees, shrubs, and other plants to shade buildings, intercept solar radiation, and cool the air by “evapo transpiration.”
- Buildings and pavement made of dark materials absorb the sun's rays, causing the temperature of the surfaces and the air around them to rise.

THE MAKING OF LOS ANGELES “ISLAND”

Los Angeles is a striking example of how a city was transformed into an Urban Heat Island.



Note: Temperatures are averaged over a ten-year period.

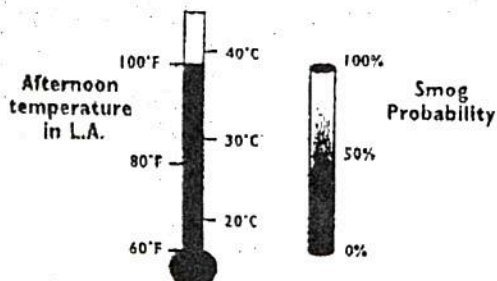
In the 1930s, Los Angeles was an area covered with irrigated orchards. The high temperature in the summer of 1934 was 97°F. Then, as pavement, commercial buildings, and homes replaced trees, Los Angeles warmed steadily, reaching 105° and higher in the 1990s.

THE SMOG CONNECTION

Urban Heat Islands are not only uncomfortably hot, they are smoggier.

Smog is created by photochemical reactions of pollutants in the air, and these reactions are more likely to intensify at higher temperatures.

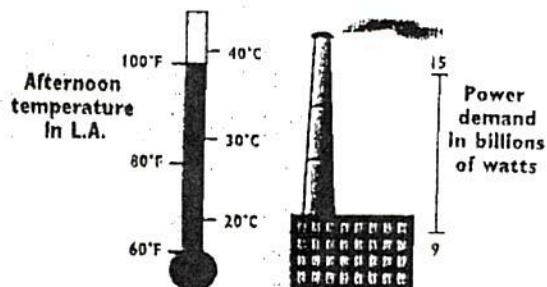
In Los Angeles, for every degree the temperature rises above 70°F, the incidence of smog increases by 3%.



THE ENERGY LINK

Higher temperatures also mean increased energy use, mostly due to a greater demand for air conditioning. As power plants burn more fossil fuels, they drive up both the pollution level and energy costs.

On warm afternoons in Los Angeles, the demand for electric power rises nearly 2% for every degree Fahrenheit the daily maximum temperature rises.



COOLING COMES NATURALLY

Trees have great potential to cool cities by shading and by "evapotranspiration."

Evapotranspiration occurs when plants transpire water through pores in their leaves. The water draws heat as it evaporates, cooling the air. One mature, properly watered shade tree with a crown of 30 feet can "evapotranspire" up to 40 gallons of water in a day, which is like removing all the heat produced in four hours by a small electric space heater.



Planting programs can help reduce urban temperatures. Within ten to fifteen years—the time it takes a tree to grow to a useful size—properly placed trees can reduce heating and cooling costs by an average of 10–20%. Over their lives, trees can be much less expensive than air conditioners and the energy needed to run them.

Correct selection and location of trees is important to achieve the best results. Two proven methods bring maximum benefit:

- Deciduous trees shading the south and west sides of a building block the summer sun. For a home monitored in Sacramento, CA, researchers found that this reduced cooling energy use by as much as 30%.
- Trees grouped together create a refreshing oasis in a city and also cool nearby neighborhoods. Grouped trees can protect each other from the sun and wind, making them more likely to grow to maturity and live longer.

DARK VERSUS LIGHT

Dark materials absorb more heat from the sun—as anyone who has worn a black t-shirt on a sunny day knows. Black surfaces in the sun can become up to 70°F hotter than the most reflective white surfaces.

Reflecting on Roofs



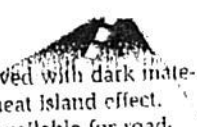
When the sun beats down on houses with dark shingle roofs, some of the heat collected by the roof is transferred inside. Staying comfortable in these homes often means more air conditioning and higher utility bills.

Scientists have found that buildings with light-colored roofs that reflect the sun's rays use up to 40% less energy for cooling than buildings with darker roofs.

A new rating system called the solar reflectance index (SRI) is being developed to measure how hot materials are in the sun. Traditional roofing materials have an SRI of between 5% (brown shingles) and 20% (green shingles). Manufacturers have recently developed clean, "self-washing" white shingles with even higher SRIs—up to 62%.

Reroofing with shingles rated SRI 50% or higher will keep a home cooler and reduce energy bills.

Paving the Way to Coolness



Roads and parking lots paved with dark materials also contribute to the heat island effect.

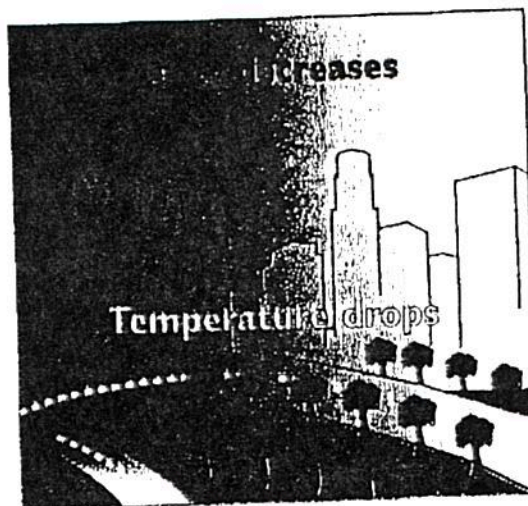
Now there are materials available for roadways that reflect more sunlight and last longer because they are not as stressed by the excessive heat. If cities began using these for paving new roads and resurfacing old ones as the need arose, they would have cooler summers at no extra cost.

IF L.A. WOULD LIGHTEN UP

What would happen in Los Angeles if some roofs and pavements were resurfaced with lighter materials and the right kind of trees were planted in several communities?

Scientists at Berkeley National Laboratory have been painting the town and shading its homes—all by computer simulation—to answer that question.

Dividing the L.A. basin into hundreds of portions, they estimated how much vegetation and reflective surfaces could be added to each location. Then they added trees and lightened surfaces in only about 15% of the possible areas. Summer temperatures at 3:00 p.m. dropped 6°F.



Because the rate of smog formation depends on temperature, this same model was used to estimate the effect on the region's smog, taking into consideration wind patterns, moisture, and other factors specific to the area. The results showed an overall reduction in smog by about 10%, the equivalent of removing three to five million cars from the roads.

COOL COMMUNITIES FOR A HEALTHIER PLANET

Urban Heat Islands have an impact beyond the city limits. The higher temperatures create more air pollution, and the greater demand for air conditioning means more greenhouse gases are being produced at electric generating plants.

Through the simple approach of planting trees and using light-colored reflective materials on roofs and pavement, city residents can be more comfortable—and take comfort in knowing that the environment is benefiting as well.



cool communities

In the United States, the Cool Communities Program is part of a national effort to prevent global warming as

outlined in the Climate Change Action Plan of 1993.

Much of the scientific research and development of materials for cooling our nation's cities is being done by the Heat Island Project at Berkeley National Laboratory. Funding for the program is provided by the U.S. Department of Energy and the Environmental Protection Agency.

AMERICAN FORESTS, a non-profit citizens' conservation group, is leading the Cool Communities outreach campaign, in cooperation with federal and local government agencies and private organizations. The program includes pilot projects in seven communities across the country.

Communities interested in taking part in the program should contact AMERICAN FORESTS at the address and phone number listed below.

*Prepared by the Heat Island Project at Berkeley National Laboratory. Hashem Akbari, Project Leader
Mark Decol, Department of Energy Program Manager*

**For information on
Heat Island research:**
Hashem Akbari
(510) 486-4287
h_akbari@lbl.gov

**For information on Cool
Community local activities:**
AMERICAN FORESTS
P.O. Box 2000
Washington, DC 20013
(202) 667-3300

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or timeliness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof, nor The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or The Regents of the University of California.

Ernest Orlando Lawrence Berkeley National Laboratory is an equal opportunity employer.

This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Technologies, U.S. Department of Energy, under contract DE-AC03-76SF00098.

PUB-775 6/96

Printed on recycled paper

Urban and Community Forestry in Pennsylvania

Municipal Tree Commissions

Forming a tree commission is one step that a community can take to create and sustain an urban forestry program. The powers and responsibilities of a tree commission are based on state statute and are assumed by local government. By forming and empowering a tree commission, a community can place the responsibility for important community decisions in the hands of unpaid volunteers with designated powers.

Tree commissions are either advisory or administrative and may have various responsibilities, including the following:

- Lessen the involvement of a municipal council for tree-related matters
- Advise community leaders and staff on administering the community forest
- Stimulate and organize tree planting and maintenance
- Develop and implement urban forest inventories, management plans, and ordinances
- Lessen liability by arranging to remove hazardous trees and repair damage caused by trees

- Settle community disputes caused by tree removal, planting, or maintenance

In Pennsylvania, a tree commission created by municipal ordinance as a decision-making body has exclusive control over a community's shade trees. No tree can be planted or removed within the public right-of-way except under the auspices of the tree commission. This includes public trees that may be planted or removed in conjunction with subdivisions or approved development plans. Tree commissions can be given additional power within a municipality by a council, including:

- Control over all public trees such as trees within community parks
- Review and approval of landscaping proposed in development plans

Formation of a tree commission and development of a comprehensive urban forestry program usually take place together. While working with community officials to start a tree commission, citizens also can undertake other aspects of a community tree program, such as fund-raising and developing tree



inventories. A tree commission should reflect the values and standards of the community and should help champion a community forestry effort. The formation and empowerment of a tree commission can be a crucial element in developing broad-based support for community trees and ensuring long-term success and continuance of a community forestry program.

The following steps may be taken in forming a tree commission:

1. Organize interested citizens and informally outline problems and opportunities for a tree commission to address. Identify specific occurrences or situations (such as tree failures, tree removals, pruning, sidewalk damage, or tree planting) that have caused community conflict or liability. Describe benefits that are expected to result from an organized tree program (such as lower community liability, higher

PENNSTATE



College of Agricultural Sciences

real estate values, more attractive commercial areas, and healthier trees).

2. Contact other communities with tree commissions or other experts, such as the Department of Community Affairs or Penn State Cooperative Extension offices, for advice and support.
3. When ideas and plans are well organized and fairly complete, contact local government leaders and identify a municipal official who is interested in working with the group. It is important to include municipal officials early in any effort to organize a tree commission.
4. Hold informal meetings with concerned citizens and local officials to discuss ideas and plans. Contact the municipal solicitor to discuss how a tree commission can be legally established within a community.
5. Identify and agree upon the powers, authority, and responsibilities of the tree commission, through meetings with municipal council members, officials, and the solicitor.
6. Involve community members through public hearings and other opportunities for public participation and response.

7. Develop or rewrite the ordinance that legally establishes the tree commission and defines its authority and powers.

8. Seek the council's approval of the ordinance at a public hearing.

Municipal ordinances establishing and empowering tree commissions should contain the following sections:

- number of commission members
- experience or expertise required of members
- place of residence
- compensation, if any
- length of terms
- rotation of terms
- vacancies
- duties
 - adjudicate tree-related matters
 - approve permits for tree removal, planting, or pruning
 - review hazardous trees every year
 - provide educational opportunities and materials
 - arrange for tree planting
 - arrange for tree and stump removals
 - oversee pruning and other maintenance

■ power

- advisory or managerial
- trees on public right-of-way or all public property
- landscape plans for street trees or include development sites

Ordinances establishing shade tree commissions also can:

- mandate a municipal arborist or forester position
- mandate and outline the creation of a municipal forestry master plan
- outline required standards and guidelines for tree planting and maintenance

Tree commissions can have a great impact on a community's appearance and image as well as its public safety and comfort. Commissions help champion and coordinate a comprehensive and expert program to manage and sustain public trees. They provide long-term, stable management for a valuable, long-lived resource. By forming a tree commission in your community, you can help improve the attractiveness of your community and its quality of life and environment.

The Pennsylvania Urban and Community Forestry Program is a cooperative effort of the state Department of Environmental Resources (DER) Bureau of Forestry and Penn State with leadership provided by the Pennsylvania Urban and Community Forestry Council.

For more information, contact the Extension Urban Forestry Program, School of Forest Resources, The Pennsylvania State University, 100 Ferguson, University Park, PA 16802; (814) 863 7041.

Published for the Pennsylvania Urban and Community Forestry Council by the School of Forest Resources.

The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 201 Willard Building, University Park, PA 16802-2801; tel. (814) 863 0471.



Pennsylvania
Urban and Community
Forestry Council

*Phila. is part of a study on cities' air quality.
Urban forests may be at the root of one solution.*

Ozone researchers branch out

By George Roomson
INQUIRER STAFF WRITER

Looking like archaeologists out on a dig, two men in jeans, boots and open-necked shirts made their way into Fairmount Park from Henry and Valley Avenues in Roxborough. Down a steep incline they went, maneuvering carefully among the rocks and underbrush.

"They paused at an oak tree. 'This spot will do,' one said. With a measuring tape, the men defined an area of about 100 yards — with the tree at the center — and then marked it with orange construction cones.

Jim Guthke, 25, and Richard Vinz, 24, are urban foresters. They spent five weeks in Philadelphia recently studying trees. They counted them. They measured their height and circumference and examined the soil to determine how fertile it is. Their aim was to learn how the city's vegetation affects the quality of the air.

The size and number of trees can influence levels of ozone in the air; bigger and healthier trees are reputed to be effective in removing ozone, the main component in smog.

A corrosive pollutant, ozone affects respiration when it builds to high levels on hot, sunny days.

Previous studies have shown that urban forests can be used to improve air quality in cities. But more detailed information is needed before a well-defined plan can be put in place, said David Nowak, a scientist at the U.S. Forest Service who is one of those involved in the study.

Said Vinz: "We know that trees help reduce the ozone but we don't know how much."

See OZONE on B6



The Philadelphia Inquirer / MICHAEL MALLY

Jim Guthke, an urban forester, takes down data on leaf cover in a plot in Fairmount Park. The measurement will be used to learn how trees affect the city's air quality.

When it comes to air pollution, trees may be at root of solution

OZONE from B1
In a study, Vinz and Guthke not only counted trees, they also examined concrete, cement, rocks and build-

A complete survey will show how different surface types affect the temperature and air quality, they said.

Surfaces, such as concrete, heat while forested areas absorb heat, Guthke said.

Ozone is created when volatile organic compounds and nitrogen oxides are found, for example, in auto exhaust — react with heat and

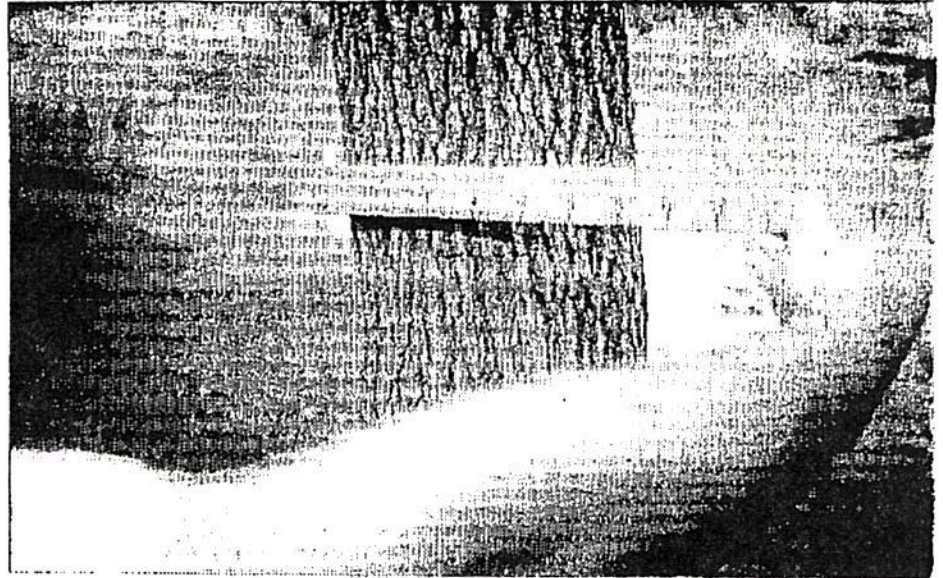
sunlight. It is a naturally occurring ozone in the stratosphere — 10 miles up — that helps protect the sun's harmful ultraviolet rays. But at ground level, it is a health hazard.

Levels of ozone pollution in Philadelphia are in much of the rest of the eastern United States, are higher than those permitted under federal guidelines, according to a report on air quality prepared by the U.S. Health Department.

The federal standard for the pollution is 0.12 parts-per-million of ozone in a liter of air over a 24-hour period. Last year, the Philadelphia area exceeded that 45 times.

In a single year, the effects of ozone could send about 3,250 people to hospitals and emergency rooms in the Philadelphia region with asthma, bronchitis or other respiratory ailments, according to a report by the Harvard School of Public Health released in June.

A federal survey of the city is part of a \$150,000 study that already included data from New York, Los Angeles and Boston. It is funded by the National Urban and Community Forestry Advisory



The Philadelphia Inquirer / MICHAEL MALI

Among the statistics the urban foresters are collecting are tree variety, number, diameter and height, as well as soil fertility.

Council, a body established by Congress in 1978.

Organizations interested in participating must match Advisory Council funding with their own contributions of money or services.

In Philadelphia, the Fairmount Park Commission, City Council and the Morris Arboretum of the University of Pennsylvania are contributing services to the study.

The field work in Philadelphia, which began in early August, was completed last week, said project designer Chris Luley.

The information will be added to other data gathered by the Environmental Protection Agency and the National Weather Service to determine how much toxic gas the trees pull from the air, he said.

Scientists who worked on the study say they have found far more trees in the city than they imagined.

"Philadelphia is a lot more wooded than many other cities," said Vinz.

Fairmount Park, the largest urban park in the United States, occupies 8,900 acres and has close to 1 million trees, said Fairmount Park manager Nick Sambor. He said there were more than 250,000 trees on city streets.

Nowak said the data collected by the researchers would help scientists demonstrate the effect of increased or decreased levels of vegetation in cities on air quality, Nowak said.

The models they prepared should be completed by next summer.

"If successful, this research may help bring out a new ozone management strategy that can be used in maintaining and achieving air quality improvement goals," Nowak said.

